

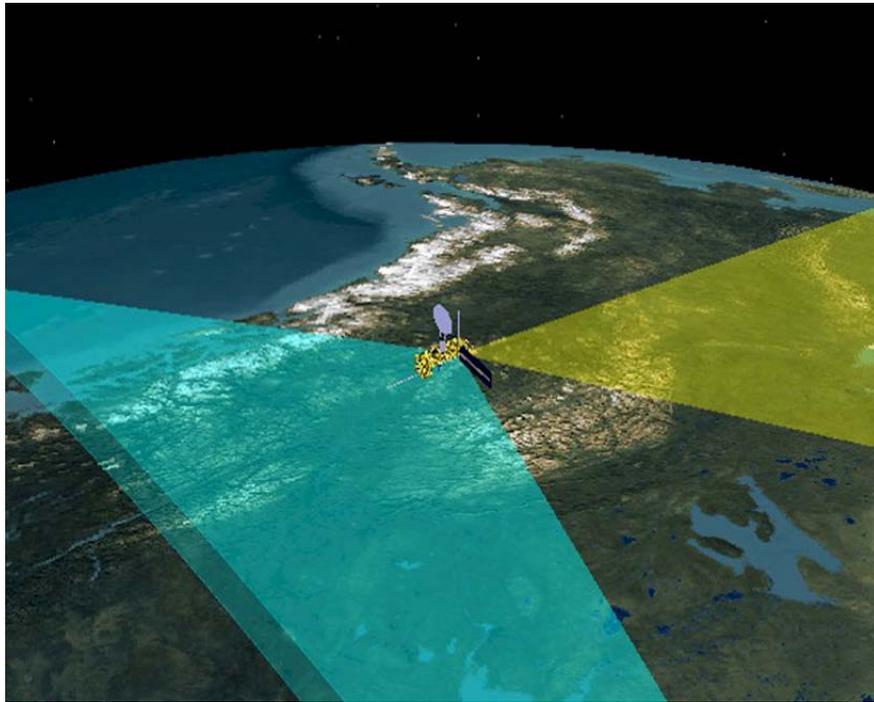


## IGARSS Workshop on NPOESS

### Introduction to Ozone Measurements from the Ozone Mapping and Profiler Suite (OMPS)

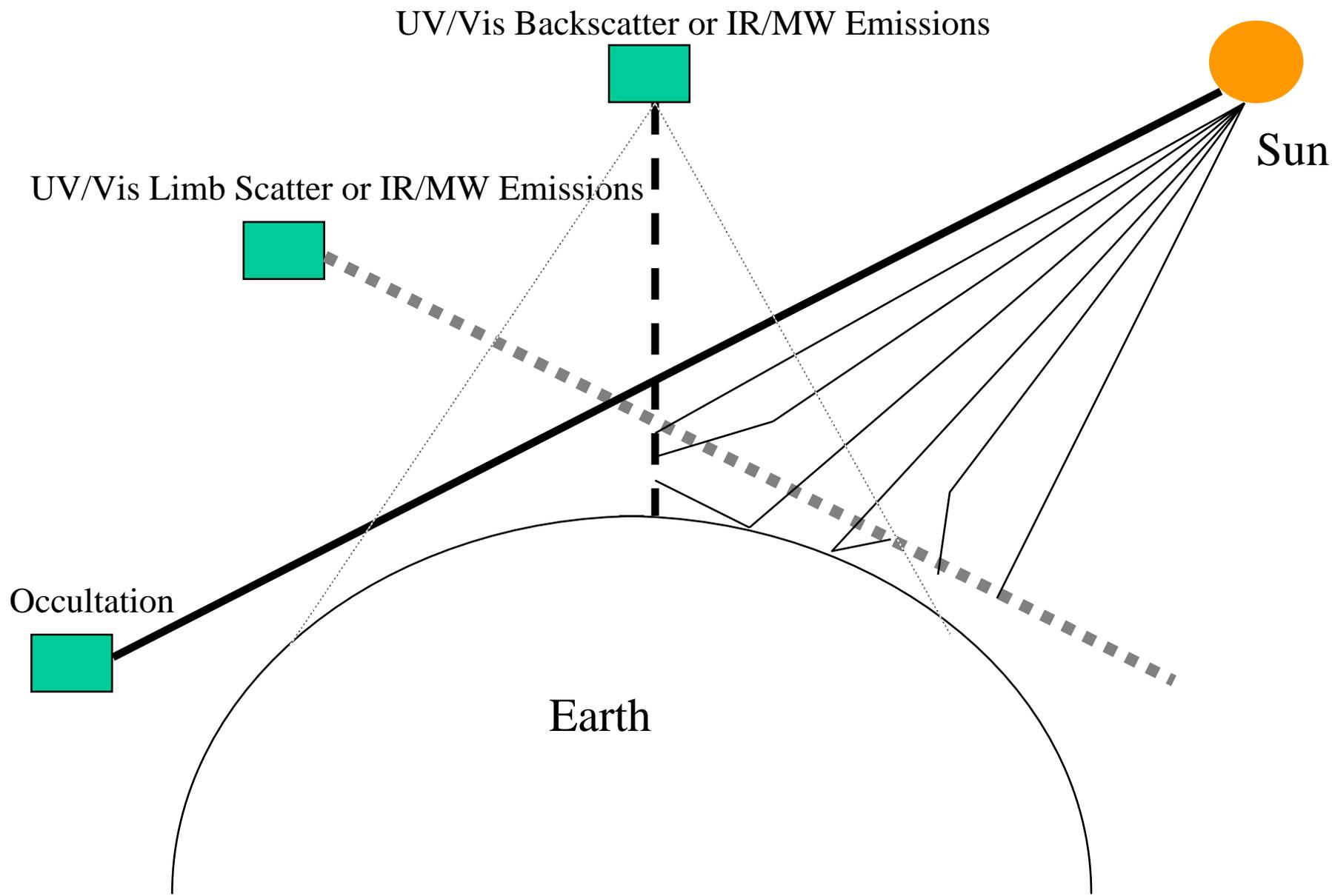
1. Types of Ozone Measurements
2. Optics, Detectors and Instruments
3. Forward Models
4. Basic Physics of UV/Visible Scattered Light
  - 2.a Absorption
  - 2.b Weighting functions
5. Backscatter UV Retrievals
6. Validation and Time Series

The OMPS program will create five ozone data products:



- High performance Total Column EDRs
- Heritage TOMS Total Column data records
- High performance Nadir Vertical Profile EDRs
- Heritage SBUV/2 Nadir Vertical Profile data records
- IR Total Column data records from CrIS

# Space-Based Ozone Instrument Viewing Geometries.



# Table 1. Ozone Satellite Timeline (from IGOS)

INSTRUMENT	MISSION	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
SAGE III	Meteor-3M			█	█												
	ISS					█	█	█	█	█	█	█					
	FOO																
SMILES	ISS				█	█	█	█	█	█	█	█					
POAM	SPOT-4	█	█	█													
SBUV/2	NOAA-11	█	█														
	NOAA-14	█	█														
	NOAA-16	█	█	█	█												
	NOAA-M			█	█	█	█										
	NOAA-N				█	█	█	█	█								
	NOAA-N <sup>1</sup>								█	█	█	█					
ILAS-2	ADEOS-2			█	█	█	█	█	█	█	█	█	█	█	█	█	█
SOFIS	GCOM-A1								█	█	█	█	█	█	█	█	█
SOFIS	GCOM-A2																█
OSIRIS	ODIN		█	█													
Microwave	ODIN		█	█													
ACE	SciSAT			█	█	█											
ERS-2	GOME	█	█	█													
GOMOS	ENVISAT			█	█	█	█	█									
SCIAMACHY	ENVISAT			█	█	█	█	█									
MIPAS	ENVISAT			█	█	█	█	█									
HIRDLS	EOS Aura					█	█	█	█	█	█						
MLS	EOS Aura					█	█	█	█	█	█						
TES	EOS Aura					█	█	█	█	█	█						
OMI	EOS Aura					█	█	█	█	█	█						
GOME-2	METOP						█	█	█	█	█	█	█	█	█	█	█
OMPS	NPOESS											█	█	█	█	█	█

# Instrument Systems

- Field-of-View and Coverage
- Wavelength Range and Resolution
  - Bandpass
  - Wavelength scale
- Detector Type
- Calibration
  - Earth to solar ratio, Multiple diffusers
  - Onboard or vicarious
  - Pairs and DOAS

## Ozone Mapping & Profiling Suite

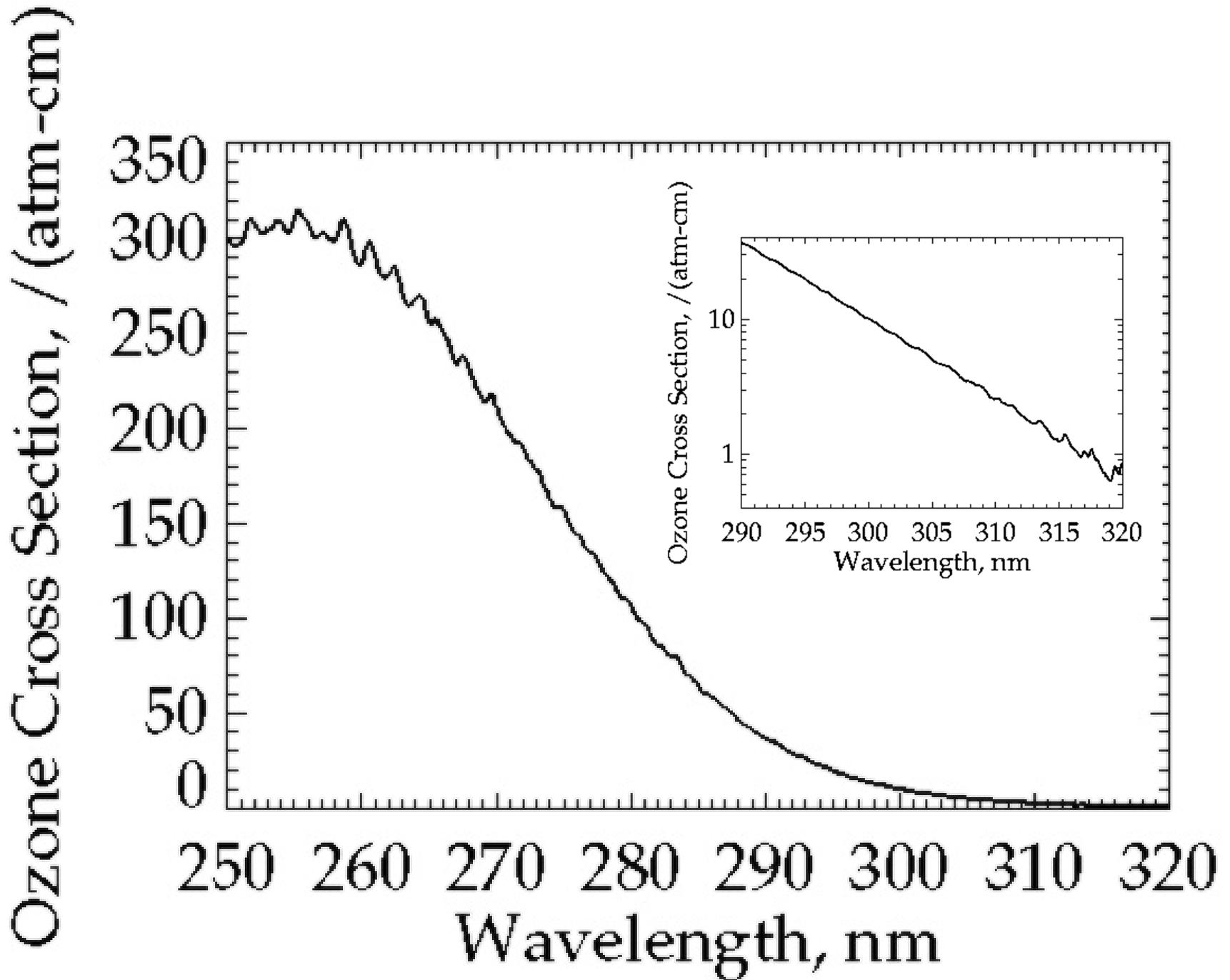
- Total Ozone Mapper UV Backscatter, grating, 2-D CCD array
  - TOMS, SBUV(/2), GOME(-2), OMI, SCIAMACHY
  - 110 deg. cross track, 300 to 400 nm spectral
- Limb Profiler UV/Visible Limb Scatter, prism, 2-D CCD array
  - SOLSE/LORE, OSIRIS, SAGE III, SCIAMACHY
  - 3 100-KM vertical slits, 290 to 1000 nm spectral
- Nadir Profiler UV Backscatter, grating, 2-D CCD array
  - SBUV(/2), GOME(-2), SCIAMACHY, OMI
  - Nadir view, 250 km cross track, 270 to 310 nm spectral

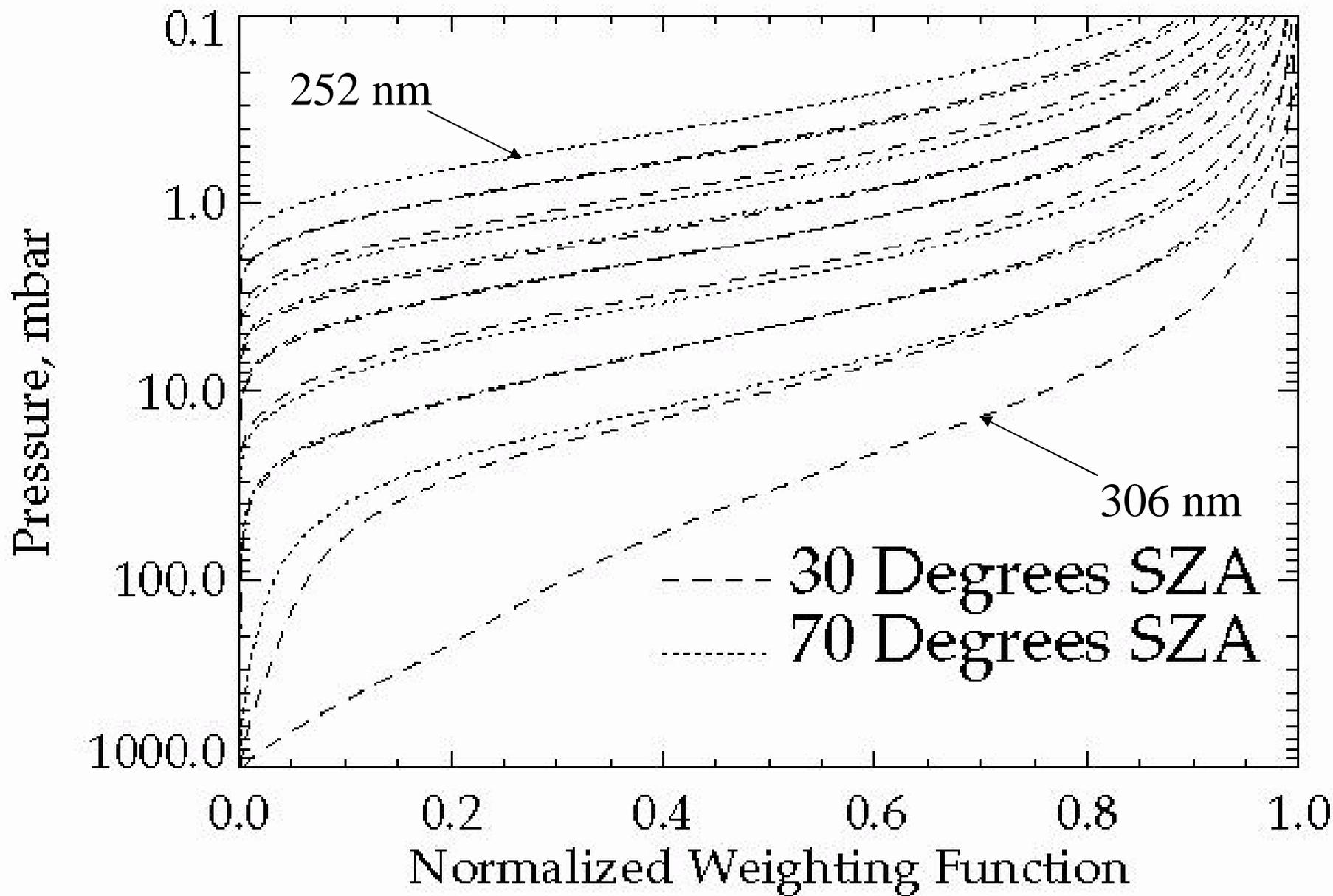
Table 2. Selected BUV missions with spectral capabilities.

Name	Start Year	Spectral Coverage	Resolution	Sampling
SBUV(/2)	1979+	200 – 400nm*	1.10nm	0.14nm
GOME(-2)	1995++	240 – 400nm^	0.25nm	0.10nm
SCIAMACHY	2002	240 – 400nm^	0.25nm	0.10nm
OMI	2004	270 – 500nm	0.50nm	0.20nm
OMPS	2009	250 – 380nm^	1.00nm	0.40nm

+ 1985,1989,1995,2000,2002,2004,2007. ++ 2005,2009. +++2002

\* When operating in sweep mode. ^ Additional detectors in visible and IR.





# Radiative Transfer Forward Models

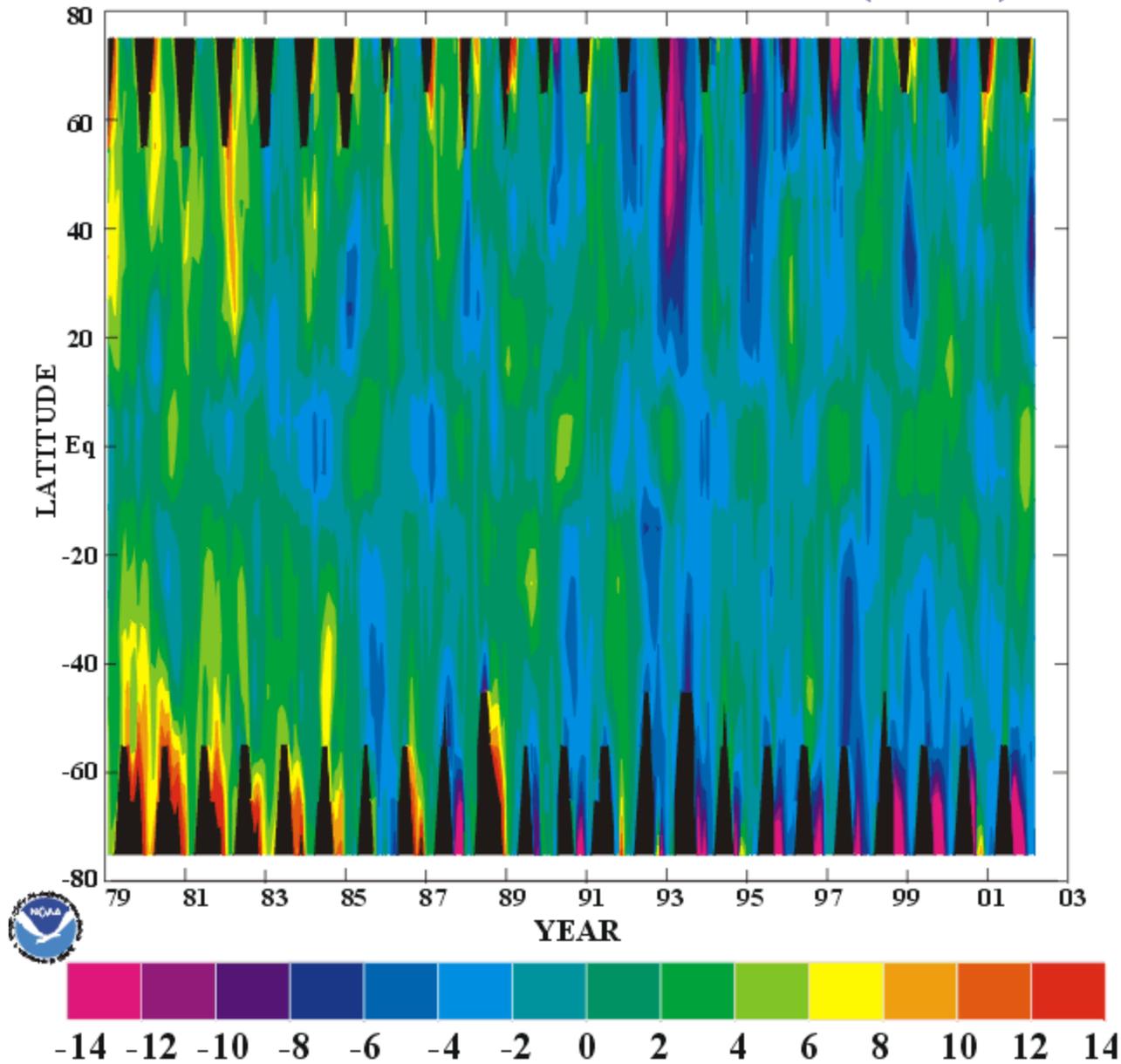
- Computational Methods
  - Partial derivatives and adjoints
- Plane or Spherical
- Orders of Scattering
- Clouds (height, reflectivity, fraction)
- Polarization
- Aerosols
- Other Species
- Inhomogeneities
  - Ozone
  - Surface or clouds

# Ozone Retrieval Algorithms

- Total Ozone
  - Pairs and triplets + standard profiles
  - DOAS + standard profiles
- Profile Ozone
  - Nadir
    - Maximum likelihood + *a priori*
    - Hyperspectral
  - Limb
    - Next talk

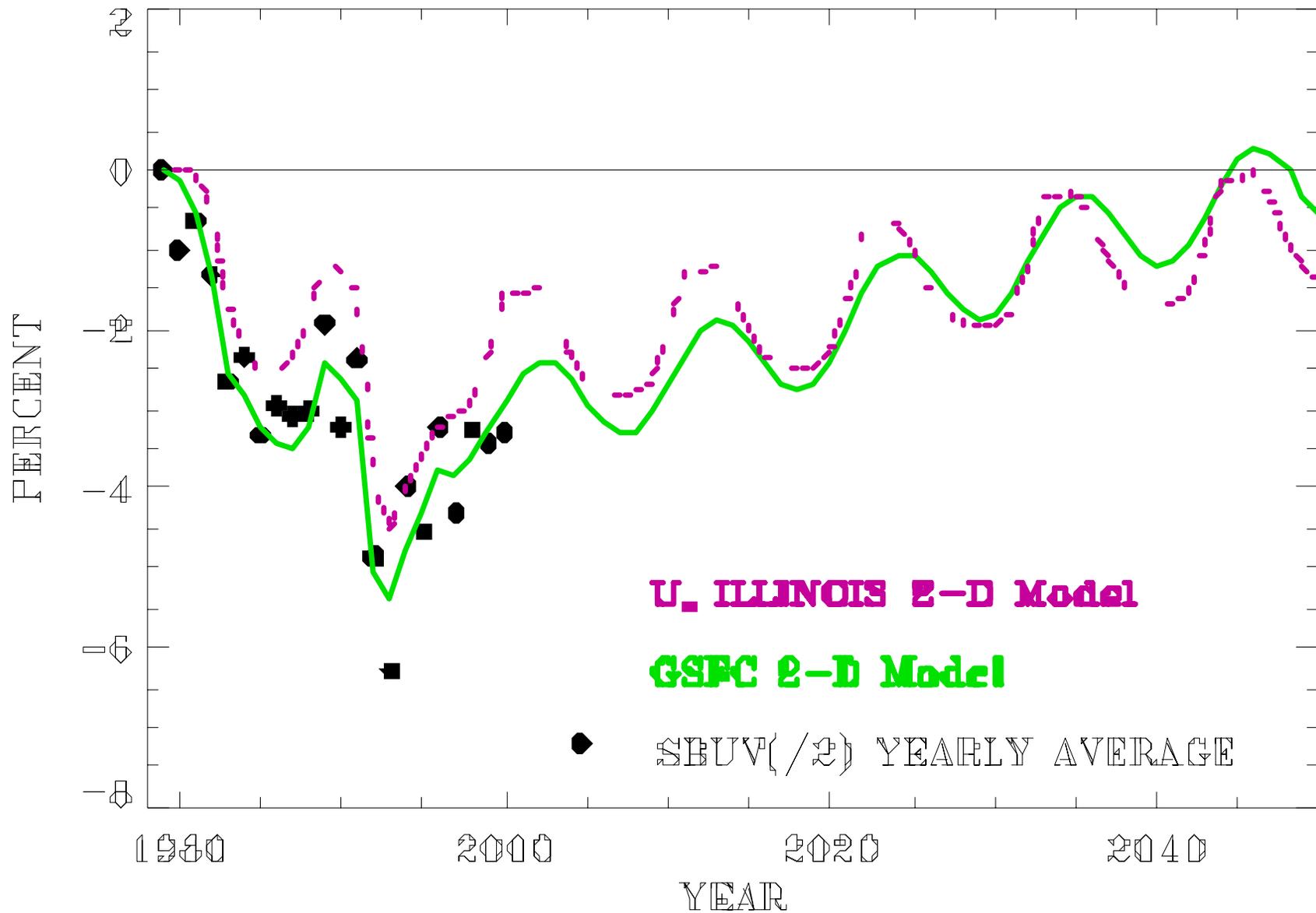
Algorithm Theoretical Basis Documents for OMPS are available at  
<http://www.npoesslib.noaa.gov>

## SBUV & SBUV/2 Total Ozone Anomalies (Percent)



**Figure 1.** Time series of monthly average anomalies (percent) of zonal mean total ozone derived from Nimbus-7 SBUV (11/1978-02/1985), NOAA-9 SBUV/2 (03/1985-12/1988), NOAA-11 SBUV/2 (01/1989-12/1993), NOAA-9 SBUV/2 (01/1994 - 12/1995), and NOAA-14 SBUV/2 (01/1996 - 06/1998), NOAA-11 SBUV/2

# PERCENT OZONE CHANGE SINCE 1979 (50N-50S)



# OMPS Technical Issues

- Limb profiler radiative transfer
  - Reflectivity variations below LOS
  - Aerosols
  - Ozone inhomogeneities
- Pointing requirements - height registration
- Stray light - range of signals
- CCD Array pixel-to-pixel differences
- SNR, height normalization, apertures and integration times
- Bandpass and wavelength scale
  - Jitter
  - Thermal effects

## Other Miscellaneous Issues

We hope that OMPS will fly on NPP (the NPOESS Preparatory Project).

<http://www.ipo.noaa.gov/npp.html>

OMPS is under consideration for a Bridge TOMS mission to fill in the gap between OMI and OMPS.

More information on OMPS and NPOESS is available at

[http://npoesslib.ipo.noaa.gov/atbd\\_omps.htm](http://npoesslib.ipo.noaa.gov/atbd_omps.htm)

[http://www.ipo.noaa.gov/ipo\\_org.html](http://www.ipo.noaa.gov/ipo_org.html)

<http://www.ipo.noaa.gov/omps.html>

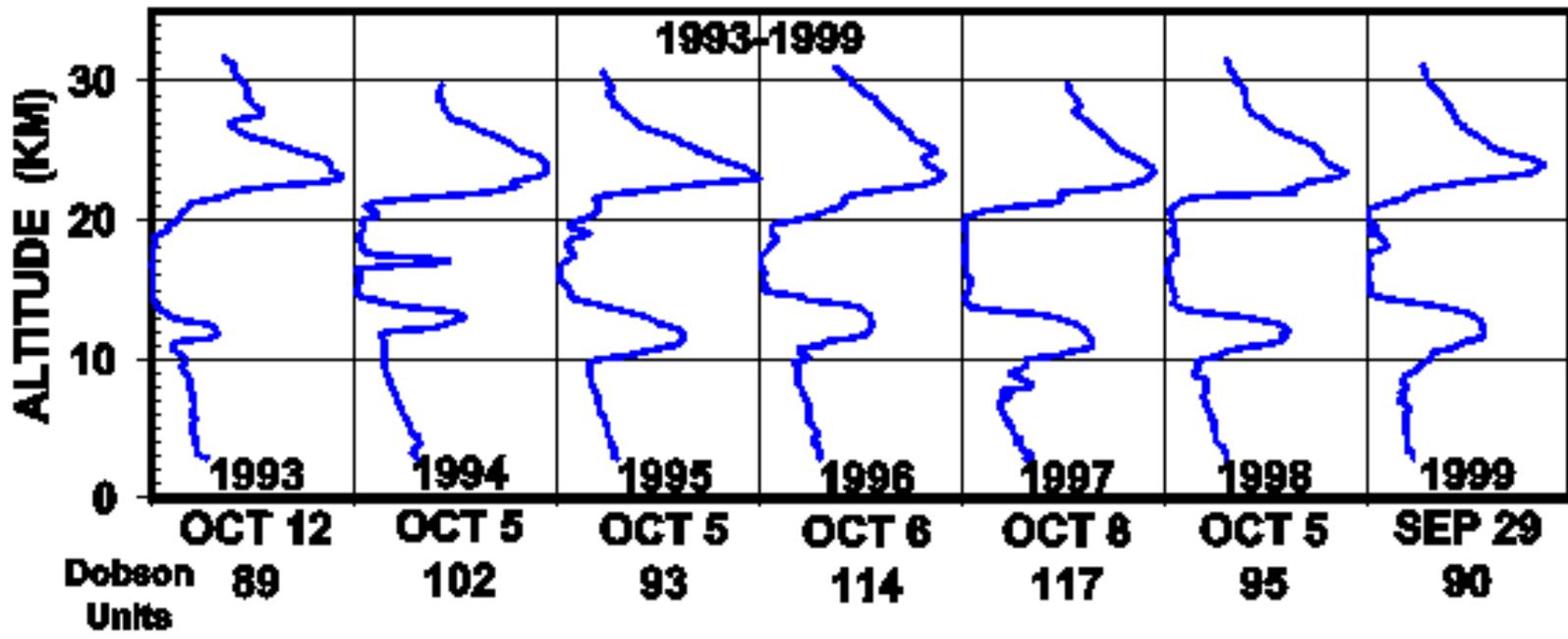
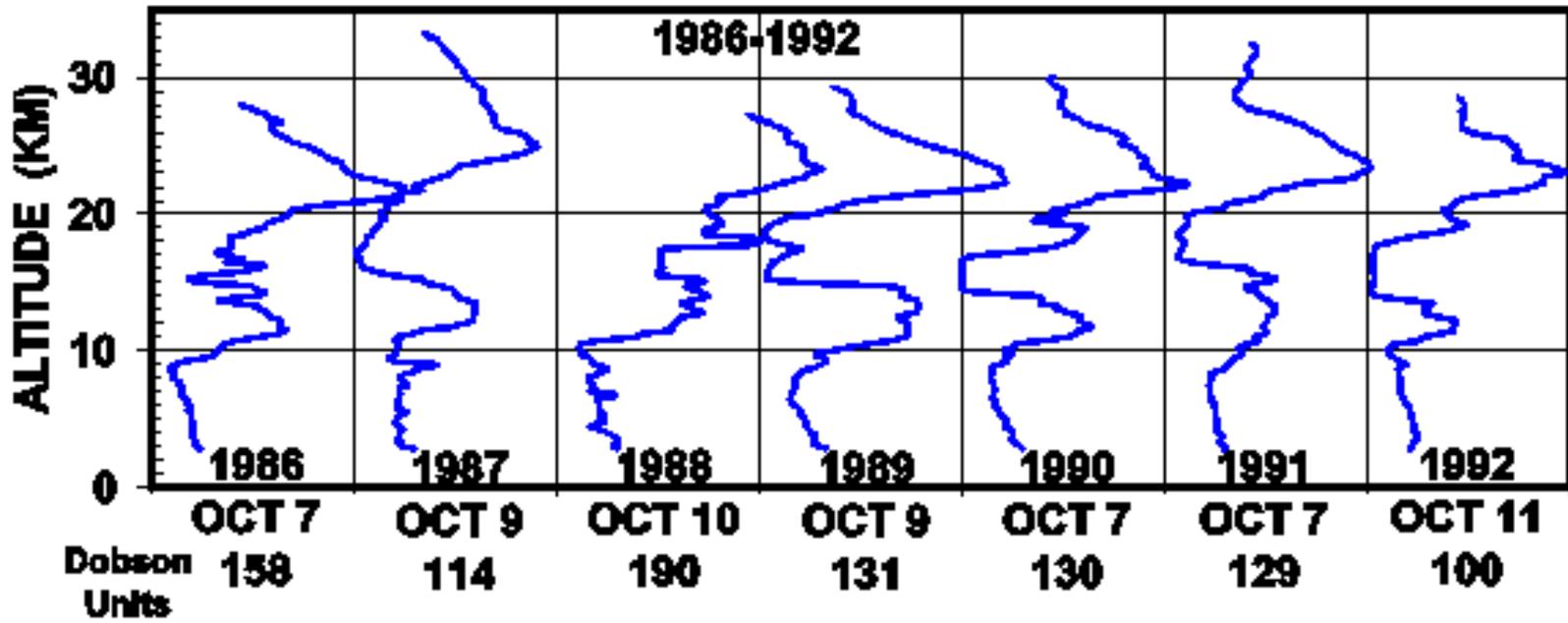
<http://npoesslib.ipo.noaa.gov/ElectLib.htm>

The principle calibration concept for OMPS uses multiple diffusers.

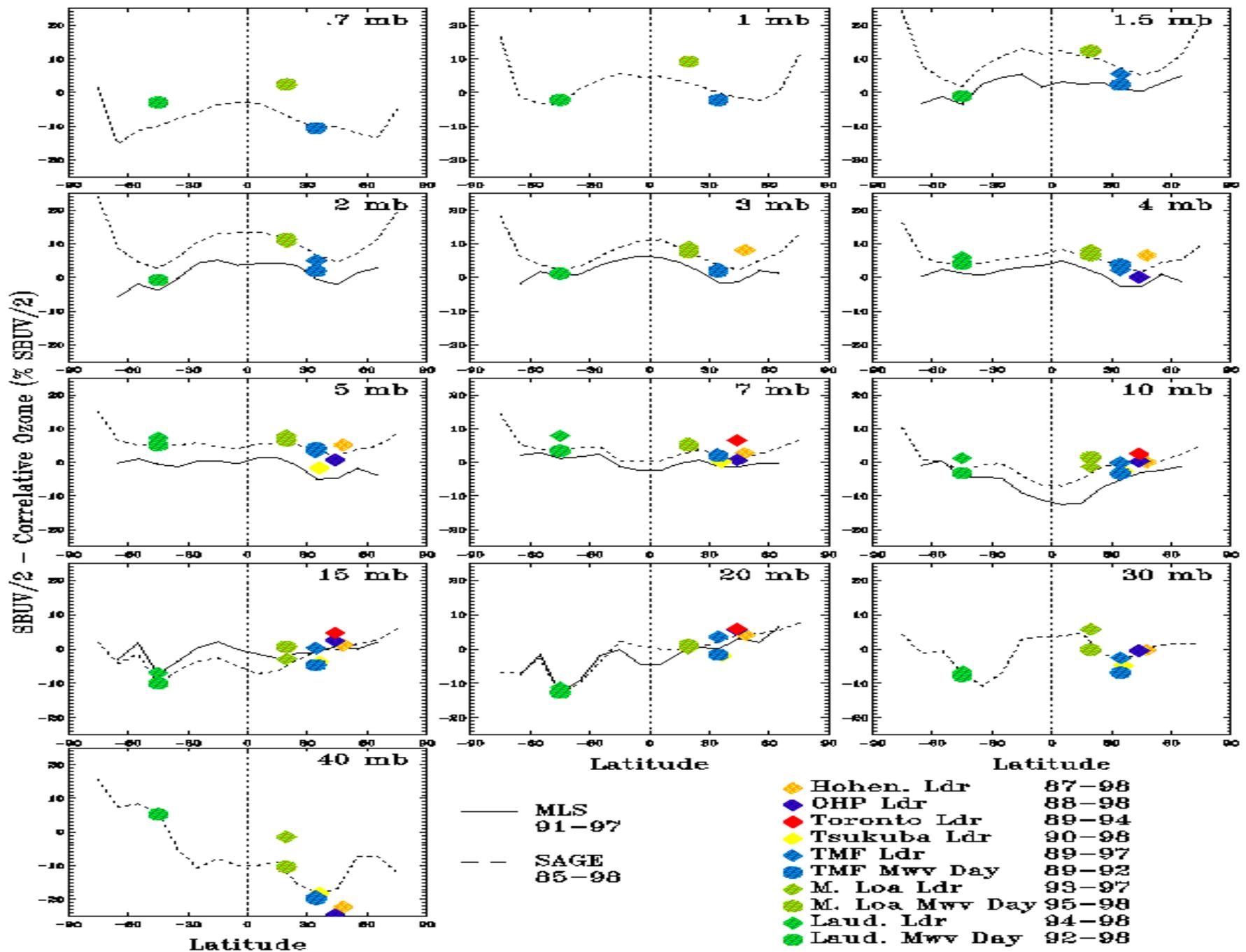
DOD is now participating as an Ozone EDR user.

The South Atlantic Anomaly is a problem for our CCD array detectors.

# Minimum South Pole Ozone Sonde Profiles



## Zonal Average Differences      Adjusted



# Sensor Concept

